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amount of his ransom, with an assurance on the part of the government, that provision should immediately be made for procuring the release of his unfortunate fellow sufferers, who were yet in slavery. From these prompt and liberal aids of the government, we are encouraged to hope, that more effectual measures will speedily be adopted, than have hitherto existed, for redeeming such Americans, as may hereafter be cast on these inhospitable shores. Two of the number, whom Capt. Riley left behind in the desert, Porter and Robbins, have since been redeemed by the indefatigable exertions of Mr. Willshire, and have arrived in this country. In his letters to Capt. Riley, inserted at the close of the book, Mr. Willshire mentions having heard of three others in Suse, or somewhere in the northern parts of the desert, and expresses a sanguine hope, that he shall be able, with the funds he had received from our consul, to procure their redemption, and restore them again to liberty, their country and friends.

ART. XVIII. *An Elementary Treatise on Mineralogy and Geology; being an introduction to the study of these sciences, and designed for the use of pupils—for persons attending lectures on these subjects—and as a companion for travellers in the United States of America. Illustrated by six plates.* By Parker Cleaveland, professor of mathematics and natural philosophy, and lecturer on chemistry and mineralogy in Bowdoin College, member of the American Academy, and corresponding member of the Linnæan society of New England.

> ————item est in viscera terræ;
> Quasque recondiderat, Stygiisque admoverat umbris,
> Effodiuntur opes———— OVID.

Boston; Cummings & Hilliard, 1816, 8vo, pp. 668.

THE author of an elaborate, elementary treatise on mineralogy in this country is no common adventurer; a few only among us, have learned to love stones, to find inexhaustible variety, and exquisite beauty in productions, far removed from the vulgar, and commonly to be found by those only who can enjoy them. Such an author has to contend with the reflection, that he must make readers for his book. Most men know a bird from a fish, or a plant from an insect, but thousands are puzzled to distinguish a metal from an earth, and will confound the most brilliant crystalised specimens, with some of the commonest productions of art. But what is still worse for the author, there is perhaps as much indifference towards his favourite science, as there is ignorance of it. He may therefore reasonably tremble for the fate of the volume, which much labour may have produced, when the unwelcome suspicion pains his mind, that if men have detected no beauty in the objects themselves, and never dreamt of their utility or interest, they will shrink from his language of description, and no sooner return to the labour of reading, than they would attempt the toil of blowing rocks, or digging a mine.

But from the depressing influences of such indifference, and so much ignorance, an author on mineralogy, has only to turn to those who love his favourite science, and he will find all that there is in zeal to encourage him. He will find, that devotion to mineralogy has, in some instances, amounted to romance;—that fortune and family have been almost sacrificed to it;--minerals metamorphosed into social beings, and the vulgar forms of metals called money, cheerfully exchanged for shapeless masses of ores, that better coinage, which takes place in the bowels of the earth. An author in this country, however, must not calculate on many readers of this class, who are no less than the extraordinary productions of a society and science a good deal advanced. It is composed of men of ardent, enthusiastick minds, who have accidentally been led to collect minerals, and who would have been devotees to any opinions or pursuits, which chance might have indicated.

Another source of temporary failure to our mineralogical authorship is, that mineralogy still wants here the high sanctions of taste and fashion. Our leaders of fashion and taste, would have been utterly confounded, had they a few yeas ago been suddenly conveyed to the Royal Institution, in Albermarle street, London; for they would have found there, not venerable philosophers gravely listening to theories of the earth, or watching with deep interest the progress of experiment; but fair ladies, and fashionable gentlemen, now taking notes, now passing about rude masses of granite, basalt, &c. or audibly applauding the lecturer for his nice tact at oryetognosy, his profound researches in geognosy, or above all for his astonishing achievements in chemistry.

Mr. Humphrey Davy, however, (for such was his address when we had the pleasure to hear him,) was the lecturer, of all others we have ever met with, the best calculated, either to create taste for science, or to lead science itself. He has been bold enough to travel over ground which had been trodden by all his scientifick predecessors, and from those very regions, so thoroughly explored, he has returned, not merely to amuse us with a new itinerary, but absolutely to displace knowledge, which had been collected with extreme labour, directed by great talent, and to new model some of the longest established principles. But with all his science, Mr. now Sir Humphrey Davy was so little encumbered, that he found opportunity to store his mind with a great variety of general information and anecdote, which gave a peculiar interest to his lectures. He illustrated geology by excellent coloured drawings of strata, mountains, &c. and did not think it beneath the dignity of the place or the occasion, when discoursing on volcanoes, to gratify his audience by an actual eruption from a miniature of Vesuvius, which lay on the table before him.

The effect of all the interest thus excited, was not perhaps an immediate advancement of science. But in the interest itself, science found a sure patronage, and its cultivators a powerful motive to unremitting exertions. What will not men of fortune pay for their luxuries ? and what luxury more commendable than science ? In the Royal Institution, the splendour of science tells us at once that it is a luxury. The discoveries, however, that have been made there ; its immense library, its late periodical publications, successful rivals, even of the transactions of the royal society, give it the highest tone of character, and claim of philosophers a tribute, that fashion, taste, or luxury, have perhaps never before urged.

But how, it may be asked, is all this connected with the success of scientifick publications ? It has this very striking connexion, where knowledge has such sanctions, it must necessarily become popular. Books which are among the best means for its communication will be purchased. Authors will be rewarded for their labour, and if their works are valuable, and of general interest, they will become sure sources of reputation, and even distinguish the country in which they are produced. It would appear then, that an author must look for success, not so much to the actual state of the learning of a country, as to its influences ; and if it be his fate to write in an age, or in a country, in which these influences have neither made science an object of fashion nor taste, the success of the work must depend very much on its own powers to produce these effects. It must stand in the relation of an agent in its own reputation, as well as contain the materials. If it be an elementary treatise, it has still greater difficulties to contend with. The great object of such works is purely instruction. They are not written for men, whose personal labours have given wider boundaries to their own acquisitions, than the author has reached in his ; but for those who perhaps have only heard of the pleasures, and permanent value of knowledge, or who, having entered with zeal on its labours, are willing to continue their researches.

If the preceding remarks be true, a hasty glance at the present state of science in this country, might furnish data, from which to calculate the chances of success of the work before us.

Our researches might possibly lead to the conclusion, that taking into view the wide field offered for mineralogical labour and discovery, a great deal has not yet been effected. They would make us acquainted with a few individuals who have zealously devoted themselves to the cause, and with some who have increased among us the means of mineralogical instruction, and even of national distinction, by the rich collections, with which they have returned from abroad, to their native country. We might however still find, with two or three eminent exceptions, that our publick means of instruction in mineralogy are extremely limited. That a taste for it, which is best formed, at that period of life, in which all influences are most powerful, and which is the surest pledge that its study will be diligently pursued, can hardly be said to have appeared among us. We might not perhaps find so great a deficiency in books on mineralogy, as of interesting and well informed instructors.

A work on mineralogy, therefore, which has instruction principally in view, if it have even many obstacles to contend with, cannot but excite interest, and when the publick and private utility, as well as abstract value of the science is more generally understood, the author cannot fail of his reward. In the remarks we propose to make on this work we shall confine ourselves principally to an examination of its character as connected with the study of mineralogy. This plan will involve a general analysis of its contents. We feel safe in pursuing this course, for the industry and zeal of the author are not the only pledges of the accuracy of its minute details. On the contrary, its descriptions have been carefully collected from the best writers on the science. Prof. Cleaveland informs us in his preface, that he has adopted the general plan of Brogniart, and that the more important parts of his work are of course incorporated in the work before us. As it was totally unnecessary, and quite out of the question, to have attempted a perfectly original work on mineralogy, a better treatise, perhaps, could not have been selected for his work, than the one chosen by the author. The excellence of Brogniart does not consist entirely in the accuracy of his descriptions or histories of minerals. He has united in them the peculiarities of the great schools of mineralogy, and in this way furnished an interesting history of the science up to the time at which he wrote. Since his time, no very important revolution has taken place in mineralogical science. Many valuable books, it is true, have appeared, and in these have been recorded the discoveries which have been made. These discoveries, however, have consisted of new facts in mineralogy, such as of new species, new localities &c. rather than of important circumstances in minerals generally considered, which had been before but partially recognised, or which would tend to destroy the established systems of classification and nomenclature.

In commencing the labour of analysis, our attention is naturally called to that part of the work, which contains an 'Introduction to the study of mineralogy.' This constitutes to the student a very important and interesting part of the treatise. It contains a short, but lucid statement of the general principles of mineralogical science, and points out some of the best means for becoming acquainted with mineralogy. The student is interested in this part of the work, not merely because its study will make him familiar with the principles, but because it also contains the *language* of the science. He will find in it also an interesting discussion of the most popular doctrines on the subject of mineral classification, and a view of the methods which have been adopted or proposed for this object. The first chapter of this introduction contains definitions and preliminary observations. In the second, the *properties of minerals* are detailed, and its first section treats of *crystallography*. Under this head are arranged, —*crystallization and crystals; primitive forms; nature of mechanical division; forms of the integrant particles; structure of secondary forms; goniometer; description of crystals; nomenclature of crystals.*

> 'Crystallization, in the most limited extent of the term, is that process, by which the particles of bodies unite in such a manner, as to produce 'determinate and regular solids.' 'A crystal may therefore be defined an inorganic body, which, by the operation of affinity, has assumed the form of a regular solid, terminated by a certain number of plain and polished faces.' p. 5.

The object of this section of the treatise, is to acquaint the student with every thing that is interesting in the bodies, which have just been defined. He is especially interested about their forms; with the circumstances on which their peculiar shapes depend; with the means which most surely enable him to study their external features; or arrive at their ultimate structure; with their description, and nomenclature.

It would hardly be possible, consistently with our limits, to enter into a minute analysis, or even partial detail of the various interesting topicks, which naturally fall under this division of Prof. Cleaveland's work. We think we shall give it a correct character, if we call it an able exposition of the crystallography of Haüy. Appearing under the title of 'Properties of minerals,' crystallography takes precedence of what Jameson denominates, after Werner, external characters, and at the head of which stands the important character *colour*, and the objects of crystallography would appear in some measure separated from those characters. This, however, forms no serious objection to the general arrangement of the introduction, and taking into view the general opinions of the author, it was perfectly natural for him to present the student in the first pages of his work, with what he considers of most importance. The student of mineralogy will hardly regret the labour he will be called to bestow on a part of the science, which has attracted some of the finest minds, which have ever been devoted to natural history. He must, on the contrary, be willing for a while to study diagrams, instead of stones, and admit the postulate of the mathematician, before he attempts the demonstrations of nature. He will find that crytallography has its sects, and he should not think the time lost, which is devoted to an examination of their peculiar tenets. He will find, that it is principally indebted to Werner and Haüy for the important place it occupies in mineralogical science, and that their peculiar doctrines on this, and other connected subjects, have divided mineralogists.

Werner regards crystals under the following relations, namely, their genuineness; their shape; their attachment; their magnitude. Genuineness refers to their division into *true* and *supposititious*. The shape of crystals, however, is the circumstance on which this system is founded, and we shall devote a moment to its consideration. The number and form of the planes, faces, the edges and angles which form the contour or outline of crystals, determine their shape. Werner found that amidst the great variety of crystals, there were some simple ones, composed of but few planes, and which do not vary much in shape; and others which not only present numerous planes, but also great differences in form; that the simple are nearly allied to the complex forms, and gradually pass into them by a change in the shape of their planes. 'On this circumstance,' says Jameson, from whom we have extracted what immediately precedes the quotatation, 'Werner has founded a crystallographic system, remarkable for its simplicity, and the ease with which it enables us to acquire distinct conceptions of the most complicated crystallizations.' These simple forms, the number of which, admitted by Werner, is seven, are what he denominates *fundamental fugures*, and which he considers as the basis of others.

On the method of Werner, Prof. Cleaveland makes the following remarks;—

> 'For accurate definitions of the *terms*, now generally employed in the description of crystals, mineralogists are much indebted to the celebrated Werner. This mode of description is founded on certain assumed principles, and essentially consists in supposing the crystal to possess what is called a predominant form; and that this predominant form has undergone certain alterations, till it has acquired the actual form intended to be described.' p. 25.

To this paragraph the following note is appended.

'It is important to premise, that this mode of describing the forms of crystals is, in general, entirely artificial; that the assumption of certain predominant forms has no relation whatever to the primitive form, or the manner in which crystals are actually formed; and that the alterations, supposed to be made in these predominant forms, are not real; for a crystal, viewed as a whole, always increases during the period of its formation, whereas this method supposes certain subtractions to be made from the magnitude which the crystal once possessed.' p. 24.

This note contains in a few words Prof. Cleaveland's construction of the Wernerian crystallography. It does not on a superficial view altogether correspond with that of the distinguished pupil of Werner, and zealous promulgator of his system, Jameson. In his treatise on the Character of Minerals, this author considers the *alterations on the fundamental figure.* 'These occur,' he remarks, 'on the edges, angles and planes, and are produced by *truncation, bevelment, accumination,* and *division of the planes.*'......'When we observe on a fundamental figure, in place of an edge or angle, a small plane, such plane is denominated a *truncation.*'

'*Note.*—Werner, in assuming certain fundamental figures, and supposing them variously modified, does not propose to point out the course followed by nature in their formation. He employs a peculiar descriptive language to convey a conception of their forms, not to explain the order of their construction. When he describes a crystal as truncated on its angles or edges, he knows very well that nature does not begin by making a crystal complete, in order afterwards to truncate it more or less on one or other of its parts, he only expresses by this term the appearance the crystal presents to the eye, thus employing a well known term to express an operation of nature, which still remains to us a mystery.' *Characters of Minerals,* p. 112.

It is not with a view of bringing these paragraphs into opposition, that they are quoted together. It is rather done, on account of a seeming ambiguity in the mode of expression, in the close of Prof. Cleaveland's note, and which, without some attention to the text, and preceding part of the note, might be taken for a misconstruction of the Wernerian doctrine. It is also done to solicit from the student of crystallography a careful examination of the system of Werner, before he adopts or rejects it. It is true that this, in common with the general mineralogical method of Werner, offers crystals, and all other mineral bodies, for our examination, in the forms, and with all the other characters that intrinsecally belong to them. It is true, that by ocular inspection alone, without the aid of the goniometer, Werner ascertained the magnitude of crystals. 'In this way he determined the whole of the species in the system, and it is known that it has enabled him to do so with accuracy.'

The crystallography of Haüy differs essentially from that of Werner. It presents us with a beautiful application of the analytical method in ascertaining the ultimate structure and forms of crystals, while with an equally happy use of the synthetical method, it contemplates crystals in all the variety of their secondary forms. It borrows aid from collateral sciences, and demonstrates with mathematical precision the phenomena with which assisted vision becomes acquainted. This system is founded on what may properly be termed mineralogical anatomy, for its principles are strictly derived from a minute dissection of crystals. The surfaces or planes of these bodies are found on examination to be traversed by lines in various directions. These lines are constituted by the apposition of the laminæ of which the crystal is composed, and are denominated the *natural joints* of such a body. The dissection spoken of, consists in a mechanical division by means of a thin, sharp instrument of steel, aided by delicate percussion, of the crystal, at its natural joints. The phenomena, which interest us during this process, are as follow.

1. The fracture-surfaces, or planes exposed by splitting crystals in the direction of the joints, are smooth, and polished, and indicate that no violence has been offered to the structure of the independent small crystals, of which the whole mass is composed.

2. These planes are found to be parallel with all the planes of the crystal, or not so; and if parallel, the shape of the crystal is *not* altered, by our mechanical division.

3. If the new planes are not parallel with any of the planes of the crystal, and we continue the division, we shall find the crystal gradually undergoing a change in its form, and, when by our division these meet, that a regular figure

is obtained very different from the original crystal, and that this admits of a division parallel to its planes without undergoing any change of form. 'This new, regular form is by Haüy named the primitive nucleus; and the crystal, whose form is the same, the primitive form.' The number of these forms is six. Besides these divisions or cleaveages parallel to their planes, primitive nuclei, and primitive forms, sometimes present others, not parallel with all their planes. A division effected in these, of course, will afford us a new and more simple figure, than that obtained by the first division. These are what Haüy denominates *integral molecules*, and according to him, are the forms of the ultimate integrant atom of the crystal in question. He also found, that these molecules, if discoverable by mechanical division, may be reduced to three species.

The synthetick method regards the structure of secondary forms of crystals.

> 'These forms,' remarks Prof. Cleaveland, 'may be supposed to arise from the successive application of laminæ of integrant particles to the faces of the primitive crystal. These laminæ form a decreasing series, beginning with the layer first applied to the nucleus; and each succeeding layer is somewhat less in extent, than that which immediately precedes it. This decrement of the laminæ is produced by successively abstracting one range or more of integrant particles from the sides or angles of each layer. These abstractions may be made on all the sides at once, or on the angles, or only on some one or more of them. The planes in which these laminæ of superposition are applied to each other, are always parallel to the faces of the nucleus, and constitute, as we have seen (35), the natural joints of the crystal. It seems then, that the integrant particles first combine to produce the primitive form, and are then so arranged around this nucleus, as to produce the secondary forms.'

We shall conclude our remarks on crystallography, by the following quotation from Prof. Jameson's Treatise on Characters of minerals, 2d Edit. p. 167.

> 'In the preceding exposition of the theory of crystallography, (of Haüy), it has been supposed that the laminæ, of which the crystals of the same species are composed, proceed from a common nucleus, undergoing decrements subjected to certain laws, upon which the forms of these crystals depend. But this is only a con-

ception adopted in order to make us more easily perceive the mutual relations of the form in question. Properly speaking, a crystal is only a regular group of similar molecules. It does not commence by a nucleus of a size proportioned to the volume which it ought to acquire, or, what comes to the same thing, by a nucleus equal to that which we extract by the aid of mechanical division; and the laminæ which cover this nucleus, are not applied successively upon each other in the same order in which the theory regards them.

'The proof of this is, that among crystals of different sizes, which are frequently attached to the same basis, the most minute are as perfectly formed as the largest; from which it follows, that they have the same structure, that is to say, they already contain a small nucleus, proportioned to their diameter, and enveloped by a number of decreasing laminæ, necessary in order that the polyhedron should be provided with all its faces. We do not perceive these various transitions from the primitive to the secondary forms, which, however, ought to be discoverable, if during the process of crystallization, the pyramids resting on the nucleus were formed progressively in layers from the base to the apex. This, however, is only true in general; for it sometimes happens, in artificial crystalization, (and it is probable that it also occurs in natural bodies,) that a form, which had attained to a certain size, suddenly experiences variations by the effect of some particular.circumstance. We must therefore conceive, for example, that from the first moment a crystal, similar to the rhomboidal dodecahedron, is already a very small dodecahedron, which contains a cubical nucleus, proportionally small, and that this kind of embryo continues to increase, without changing its form, by the addition of new laminæ on all sides; so that the nucleus increases on its part, always preserving the same relation with the entire crystal.'

This section contains a description of crystals, and a translation of the nomenclature of crystals by Haüy.

In the second section of this chapter, Prof. Cleaveland treats of the physical or external characters of minerals.

'The properties of minerals are somewhat numerous, and fall under the cognizance of two distinct branches of science; hence the twofold division already mentioned (16), into physical and chemical properties or characters. But, as the *physical* characters of minerals may be ascertained by mere inspection, combined in some instances with a simple experiment, they have generally received the name of *external* characters; to describe which is the object of this section.'

This section contains a great variety of very interesting matter, and well deserves the attention of the student. External characters furnish the basis of the Wernerian Mineralogy, and in the hands of Werner, were found sufficient for all the purposes of arrangement, and enabled him very accurately to distinguish individual specimens. We shall more particularly notice this section when on the subject of systematick arrangement of minerals. It will be perceived that Prof. Cleaveland has united the *physical* and *external* characters under the same head, or rather makes them synonymous. Prof. Jameson considers physical and external characters under distinct heads, placing the first after chemical characters. His definitions would appear to warrant this arrangement.

> ' *External characters,*—are those which we discover by means of our senses, in the aggregate of minerals, and which have no reference to their relation to other bodies, or to chemical investigations.'
>
> ' Physical characters,—are those physical phenomena which are exhibited by the mutual action of minerals and other bodies; such are the magnetic and electric properties exhibited by some minerals.'

It is elsewhere observed in the same work,

> ' They [physical characters] are highly curious in a general point of view, but are seldom useful in the discrimination of minerals, as they occur but in few species; and in these rare cases the same physical properties are met with in very different species. The principal physical characters which occur among minerals are electricity, magnetism, and phosphorescence.'

If these distinctions are founded in nature, it is perhaps well to have a regard to them, even in an arbitrary arrangement. These characters are among the last mentioned by Prof. Cleaveland, and from standing together, will be easily distinguished from those characters, which are independent of the mutual action of minerals and other bodies, and which are borne on the very faces of minerals themselves. The student will find in this section, a short but useful account of the external and physical characters. We regret that it was not compatible with the original plan of the work, to have admitted a fuller detail of these subjects. The author has been able to present us little more than a catalogue of the fundamental colours, and their varieties, and of the other characters, his limits have allowed him to furnish little more than definitions. The student, however, who wishes more particular details, will find them in the Characters of Minerals, by Jameson. On the very useful character, *colour,* he will find a valuable work, printed a short time since in Edinburgh, entitled, 'Werner's nomenclature of colours, with additions, arranged so as to render it useful to the arts and sciences; with examples selected from well known objects in the animal, vegetable, and mineral kingdom,' by P. Syme, &c.

The last section of this chapter treats on the chemical characters of minerals. The third chapter is devoted to the subject of mineralogical arrangement, and the fourth to the nomenclature of minerals. In the remarks we propose to make on these subjects, we shall briefly allude to the schools which have been distinguished for their peculiar methods of arrangement, and make some general observations on the method recommended by the author.

The two principal schools, which at present interest and divide the mineralogical world, are those of France and Germany. At the head of the first stands the venerable Abbè Haüy, while the celebrated Werner is distinguished as the founder of the latter. The points at issue between these schools are those circumstances in minerals, which should serve as the basis of classification. According to Werner, their external characters are of most importance in determining species, the genera being determined by the predominant, or characteristick ingredient; or in the words of Jameson, 'The Wernerian oryctognostic system is framed in conformity with the strictest rules of classification; it is founded solely on the *natural alliances and differences observable among minerals.*' Introduc. first edit. p. xxiii. While the method of Haüy arranges minerals according to the form of their integral molecules, or integrant particles, as explained by Prof. Cleaveland; and supposes that arrangements founded on the *crystalline forms* and *true composition* are never at variance.

The French and German schools are thus characterised by Prof. Cleaveland.

'The German school seems to be most distinguished by a *technical and minutely discriptive language; and the French, by the* *use of accurate and scientific principles, in the classification or arrangement of minerals.'*

A writer on a disputed subject, let his views be ever so liberal, and the inducements for declaring his own opinions ever so small, can hardly leave the field of inquiry, without disclosing to his readers the influences which his researches may have had on his own mind. It is well that it is so, for we have hence favourite doctrines ably defended, and the nakedness, in which an opposite one is exposed, is a strong claim on the protection of its friends. From the following paragraphs from his work, we gather Prof. Cleaveland's opinions on the best method for the arrangement or classification of minerals.

'We hesitate not to answer these questions by saying, that the *true composition* of minerals ought to be the basis of arrangement; and by this only ought the species to be established. This only can give permanence of character to the species.' p. 73.—It is however to be understood, that, in all cases, where the composition is unknown, the species are to be considered provisional, till the progress of chemistry shall enable us to re-examine them.' p. 79.

Where the true composition is unknown, we are elsewhere instructed by the author, to consider those characters as next in importance, which depend more or less, on the true composition, viz. the *crystalline form* and *structure;* the form of the integrant molecule; the primitive form of crystals, and the structure and actual forms of secondary crystals.

'Where all assistance from analysis or the crystalline form is denied, the species must be determined by a well chosen aggregate of those external characters, such as structure, fracture, hardness, &c. which depend most intimately on the nature of the mineral.' In other words adopt the Wernerian method.

The paragraphs now quoted, are among the most interesting contained in the work under review. They relate immediately to the philosophy of mineralogy, and in a few words give us the opinion of the author on the subject of scientifick classification. In adopting any one of many systems, a variety of circumstances present themselves for consideration. In natural science, that method of arrangement is best which is surest. But its degree of susceptibility of a particular application to every distinct, individual object, of either of the departments of natural history, is a consideration of no trifling importance. If one science is to be judged by another, we are to consider the progress which that science has made, to which the other is to be referred, especially when it is to derive its whole character from it. If the progress of one is to stop where the other ceases to afford its aids, we have some inducement to relieve the dependent science, and to ascertain if its peculiar objects do not present, or contain within themselves all the means of scientifick arrangement. How slow would have been the progress of ornithology and entomology, had naturalists sought the bases for the arrangement of birds and insects in the structure and functions of their internal viscera? and yet how perfectly are they classed by a few, and very simple external characters? How far now, we may ask, are minerals possessed of external characteristick marks, by which they may not only be distinguished and known, but even arranged? are analogies between them in their natural state, and organised beings, so totally wanting, that in order to their scientifick classification, their natural features must be destroyed, and their characters learned only by their decomposition?

We are aware that the chemical method is more especially recommended by the author, as furnishing the surest basis of classification; that it has arrangement in view, rather than the facility of distinguishing and denominating individual specimens. It is not our purpose to offer to the chemical method, the objections which have been urged by the friends of the German mineralogy. We would only ask, whether the individuality of mineralogical science is not endangered by an arrangement and nomenclature, founded exclusively on chemical analysis? It is true, we should not offer it as great violence, as we should botany, were we to attempt to arrange plants agreeably to an analysis of their constituent or predominant elements. But is there not some danger of losing mineralogy as a distinct science, in the the theories, and splendid experiments of chemistry? And would it not in a short time be recognised as merely possessing objects of analysis, and chemical illustration, as only furnishing, in short, valuable materials for the manipulations of the laboratory? The chemical method, even when absolutely perfect, can at most but acquaint us with the kind and variety of materials of which a given specimen is made. In other words, it can do little more than acquaint us with the effects produced on minerals by certain reagents. It has little if any regard to all that is interesting, and beautiful, in the external phenomena of minerals, although these exclusively depend on their *nature* and component parts.

While it is apprehended that the above might possibly be among the consequences of adopting *exclusively* the chemical method, for the purposes of nomenclature and arrangement, we agree entirely with Prof. Cleaveland, that very important aid may be derived from chemistry to mineralogy. In teaching us what enters into the composition of minerals, although it be utterly inadequate to show the connexion between such composition, and the constant occurrence of certain very striking and distinguishing external characters, it nevertheless often adds very interesting facts to those already known. New modes of analysis, it is true, will at times discover great errours, and disturb the repose of long established opinions. And men of science are willing to part with what they have long cherished, for something that is better. The objects of natural science however always remain the same. The features of minerals are always indicative of their true composition, for they are its necessary results. We cannot therefore but feel some doubts of the expediency of adopting any method for their arrangement, which is not principally derived from characters peculiar to them, viz. their external and physical characters. As to nomenclature, we have only to refer to botany, to show that it may be perfectly arbitrary, and yet fully answer all its purposes. The characters that enable us to distinguish the mineral species chlorite, are fully adequate to that purpose, and this name as surely indicates the thing, as any other would, though chemically, and more scientifically derived from its metallick relations. It would seem hardly possible for chemistry ever to furnish a nomenclature, or method of arrangement, for the great mass of earthy fossils, into the composition of which so great a variety of substances are frequently found to enter, especially when we take into consideration the acknowledged imperfection of chemical analysis, and the still more unfortunate concession of our author, that we are unable 'to determine what ingredients are *essential* in a compound, or rather which one, two, or more of its ingredients may be most influential in producing its physical properties.'

Considered in its chemical relations, the method of Haüy naturally follows that which has just been briefly noticed. Speaking of this method Prof. Cleaveland remarks,

> 'But although he [Haüy] admits that it belongs to chemical analysis to establish the basis of arrangement, yet in determining the species, he appears to be governed chiefly by the form of the integrant particles, except in those cases, where different species have integrant particles of the same form.' p. 76.
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> 'Integrant particles are the smallest particles, into which a body can be reduced without destroying its nature; that is, without decomposing it.' p. 6.
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> 'Elementary or constituent particles are the final results of chemical analysis. They are the elements, of which integrant particles are composed. Thus, while the latter remain invariable in the same body, the elementary particles must vary with the progress of chemistry.' p. 7

The following appear natural inferences from these quotations.

1. Simple minerals, (those only being excepted which are not crystallized,) of themselves, without decomposition, furnish materials, or bases for scientifick classification.
2. Chemical analysis, however perfect, is not necessary to such classification, since its results can never be at variance with the true composition, upon which the invariable forms of integrant particles depend.
3. Chemical analysiss, in its present state, is not a sure test of the elementary particles of minerals, and hence can only be auxillary to integrant particles in determining species.

The harmony, however, which is found to exist, between the results of chemical analysis and the natural basis of the method of Haüy is only incidentally alluded to in this place. The whole originality and beauty of this method rests on its assumption of the integrant molecules of minerals as the basis of classification, or for determining species; while its whole value, depends on its susceptibility of application to all simple mineral bodies; in other words, on the simple fact, that the integral molecule is in all instances the 'type of the species.' The very striking exceptions, however, to this method, presented by various minerals, essentially diminishes its value. Jameson affirms in an unqualified manner, that the integral molecule is in no instance the type of the species, and it is notorious that diamond and spinelle, different species, have the same integral molecule; and that 'other minerals, as zeolite, that unquestionably belong to the same species, have different integral molecules,' without however adding to the objections which have been made by various authors to this method, we would merely quote the following paragraph from Jameson.

> 'Independent of the objections stated above, there is still another, and probably more forcible one to be opposed to the system of Haüy; it is, that the greater number of minerals are not crystallized, consequently according to the definition of Haüy, have no discoverable integral molecules, therefore are not species. Haüy indeed suspects that they are not species !!!' Note to p. xiii. First edition of Treatise on Mineralogy.

It remains for us, before we leave this section, to make a few general observations on the method of Werner. We have adverted to this method in the foregoing pages. Its peculiarity consists in the basis it adopts, for the important purposes of mineral classification. This basis is the external characters of minerals, or as before quoted from Prof. Jameson, the '*natural alliances and differences observable among minerals.*' 'But on what do these depend? Werner answers, on the quality, quantity, and mode of combination of the constituent parts.' It should be distinctly understood, that this answer has no regard whatever to such *qualities*, or *quantities*, of constituent parts, as chemistry, in its present state, takes cognizance of, and which might affect arrangement, 'for it is only when chemical results agree with the natural alliances of the mineral, that he [Werner] gives them a place in his system.' This method goes upon the broad and rational presumption, that the exteriour of the various objects of natural science, especially of mineralogy, have a necessary connexion, and dependence upon the quantities, qualities, and mode of combination of their component parts. If this be true, the method of Werner appears absolutely founded in nature; in other words, that his is the only *natural* method, which has been proposed for the arrangement, as well as for the study or knowledge of minerals. An inquiry into the correctness of a system, founded on such a basis as that of Werner, involves an important question in physicks. But we have not time to inquire, whether internal structure and external characters are not always consistent with each other; or whether the exceptions are not to be referred to the present narrow limits of our knowledge, rather than to an essential derangement in the operations of the laws of nature. It is no real objection to the method of Werner, that it requires a strict observance, of apparently trifling characters; of even the faintest variations of colour; for the connexion between these more delicate shades, and the truly fundamental characters is so natural, so beautifully discoverable, for instance, in colour-suites, and in all minerals, that the student soon refers to them without difficulty, and even comes to be delighted while engaged in detecting the most trifling differences.

In finding the materials of the science, in its own peculiar objects, and admitting no necessary connexion between it and other sciences, Werner has paid an honourable respect to nature, and constituted mineralogy a distinct science. He has done more than any other man, towards removing the artificial partitions which have separated the various departments of natural history, and discovered to us a beautiful analogy between organick and inorganick existences, by demonstrating that the basis of classification may be common to both. Werner's method, however, except by his exclusive followers, has either been only partially adopted, or altogether rejected by mineralogists. We perfectly well recollect the closing remark of an excellent lecturer on mineralogy, of the French school, on the subject of colour. 'I should as soon,' he remarked, 'decide on the quality, or fineness of cloth, by its colour, as determine a mineral species by this Wernerian character.'

If the student wishes fuller expositions of the Wernerian method, than were consistent with the limits of Prof. Cleaveland's work, he will find them in the work of Brochant, in the first edition of Jameson's Mineralogy, in Jameson's Characters, and in other elementary treatises.

We have hitherto been principally occupied with the speculations of mineralogical philosophers. We cannot leave this part of the work without again recommending it strongly to the attention of the student. He will leave the well written, but necessarily short details, or accounts of the theories and great principles of mineralogy it discusses, with interest awakened, and zeal excited, to enter on those practical details, which he will find in the succeeding pages. These are devoted to mineralogy properly so called. It is to this part of the work, the author must principally look for distinction among mineralogical writers. We have examined this part with care, and compared individual descriptions with those of other mineralogists. We have occasionally detected some slight deviations, from the orthography adopted in the latest works we have seen; and differences, not very important however, from the descriptions of other writers. The latest we have used for comparison is the 2d edition of Prof. Jameson's Treatise. As this appeared in Scotland, the same year in which Prof. Cleaveland's work did in America, it was impossible for him to have taken advantage of the corrections it contains. This last edition may be almost considered a new work, and we have no doubt will be consulted in a new impression of the treatise under review.

We acknowledge ourselves very much indebted to Prof. Cleaveland, for the new species with which his work has made us acquainted, and more especially for the new localities of minerals. It is on these, we conceive, that he must principally depend for the degree of interest his work will excite in Europe. His own industry, and the zeal and labour of his scientifick friends, have enabled him to furnish his book with abundant means for producing this effect. These he will be daily able to increase, and we have no doubt, as far as mineralogy is concerned, in a few years, he will have done much towards associating this country with the older, and scientifick nations of Europe.

The remainder of the volume is devoted to an Introduction to Geology, Remarks on the Geology of the United States, explanatory of a geological map of these states.

We shall not attempt an analysis of the important matter contained in the pages which are devoted to mineralogy and geology, and which constitute by far the larger part of the volume. We decline such an analysis, not merely because our limits put it entirely out of the question, but because our examinations of its contents have detected but few, and not very important deviations from standard works, and where exceptions have occurred, our own cabinets have not furnished a sufficient variety of specimens to satisfy us which description was the correct one. This we conceive the only proper ground in such a case to be taken on the question of accuracy. An author's descriptions ought to be considered correct, unless flagrantly contrary to high authority, until they are fairly tested by a minute study of the objects he describes, and a very careful comparison of them with his descriptions.

The student will find a great deal to interest him in the geology &c. which closes this volume. While the subjects are strictly scientifick, the author has given them all the adventitious interest of a pure and easy style. This branch of mineralogical science has of late attracted the attention of very able writers, and we refer the student to the works of Playfair, Jameson, and Cuvier, as admirably well adapted to satisfy the curiosity, which Prof. Cleaveland's introduction to geology may have excited.

We have taken occasion in this review to collate the opinions of the author with those of other distinguished mineralogists. We conceive that we have performed a far more important service in this way than we could have done, by any general remarks on the subjects which have come under discussion. The question of correctness or utility is thus changed from a matter of mere opinion, held by unknown individuals, and is tried by well known and high authority. We have principally used the works of Jameson for this purpose, not merely because they are expressly devoted to mineralogical studies, but because they are wonderfully free from every thing like bias towards any peculiar method, and seem to afford as perfect an account of the French and German systems, as can any where be found. We well know that he is devotedly attached to Werner, and yet these works hardly furnish a paragraph of defence, of the tenets of his illustrious master. We refer to the *last* edition of the Characters of Minerals, and of the Treatise on Mineralogy.

Before we take leave of a work which has interested us so much and so long, we would again express to the author the high sense we entertain of the value of his scientifick labours. The time and the pages we have devoted to this article are good evidences of the estimation in which we hold his work. The author has paid a part of the debt of science we owe to Europe, and than this, we know of no motive more powerful to excite him to still greater exertions.